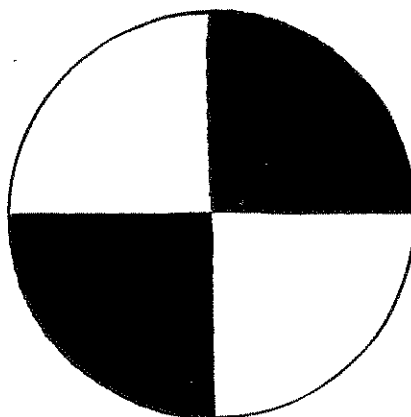


SUNSET LAKE
LAKES LAY MONITORING PROGRAM
1985

Freshwater Biology Group (FBG)
University of New Hampshire
Durham

by
Tracy E. Kenealy

Coauthored and edited by
A.L. Baker J.F. Haney



LAKES LAY MONITORING PROGRAM

To obtain more information about the Lakes Lay Monitoring Program (LLMP) contact the LLMP Coordinator (T. Kenealy) at (603)-862-3848, Dr. Baker at 862-3845 or Dr. Haney at 862-2106.

TABLE OF CONTENTS

PREFACE.....	iii
ACKNOWLEDGEMENTS.....	v
NON-TECHNICAL SUMMARY OF LAY MONITOR DATA.....	1
COMMENTS AND RECOMMENDATIONS.....	3
METHODS	
Lay Monitors.....	5
Freshwater Biology Group, UNH.....	8
RESULTS AND DISCUSSION OF LAY MONITOR DATA.....	10
REFERENCES.....	13
APPENDIX A: LAY MONITOR DATA	
Water Transparency and Chlorophyll <u>a</u> , 1984-1985....	A-1
APPENDIX B: LAY MONITOR DATA	
Total Phosphorus and Alkalinity, 1985.....	B-1

This is a LEVEL II report. (See last page for definition.)

All data in this report are available to any person or organization upon request and payment of costs involved.

PREFACE

Importance of long-term monitoring

Lake monitoring carried out weekly over the course of several consecutive summers benefits the lake in a number of ways. The resulting data not only indicate the lake's condition for a particular summer, but they also suggest what it was like in the past, and make it possible to predict its condition in the future.

For this reason, it is important to distinguish between short-term and long-term results. As an example, a 30 year time-span may provide evidence for a long-term trend towards eutrophy (Fig. 1). Yet, if one looks at data over a 1-5 year time-span, one sees only short-term fluctuations; there are no apparent trends nor is it possible to separate the "signal" from "noise". Chlorophyll, water transparency, and phosphorus may fluctuate from year to year in response to annual variations in climate and activity on the lake, and may be unrelated to long-term trends. The more such "noise" in the data, whether due to real or analytical variations, the longer a monitoring program must continue to demonstrate long-term trends.

Use of long-term trends

Long-term trends serve several important functions. From them, past deterioration of the lake can be recognized. They can also be used to forecast the future condition of

They can also be used to forecast the future condition of the lake, and if necessary, management techniques can be implemented to keep potential problems from becoming worse. Finally, long-term trends provide a basis for evaluation of existing management programs so that necessary changes may be brought about.

It takes a great deal of motivation, perseverance, and a love for one's lake to be a lay monitor. Sometimes it may seem to be an inconvenience, or to be discouraging when it's unclear just what a year's worth of hard work means with respect to the "big picture" of the lake. Yet, each observation by a lay monitor is a significant contribution.

Thus, continuation of data collection is important. The LLMP data base is becoming more comprehensive and valuable each year. We are pleased with the interest and commitment of lakeshore volunteers. Keep up the great work!

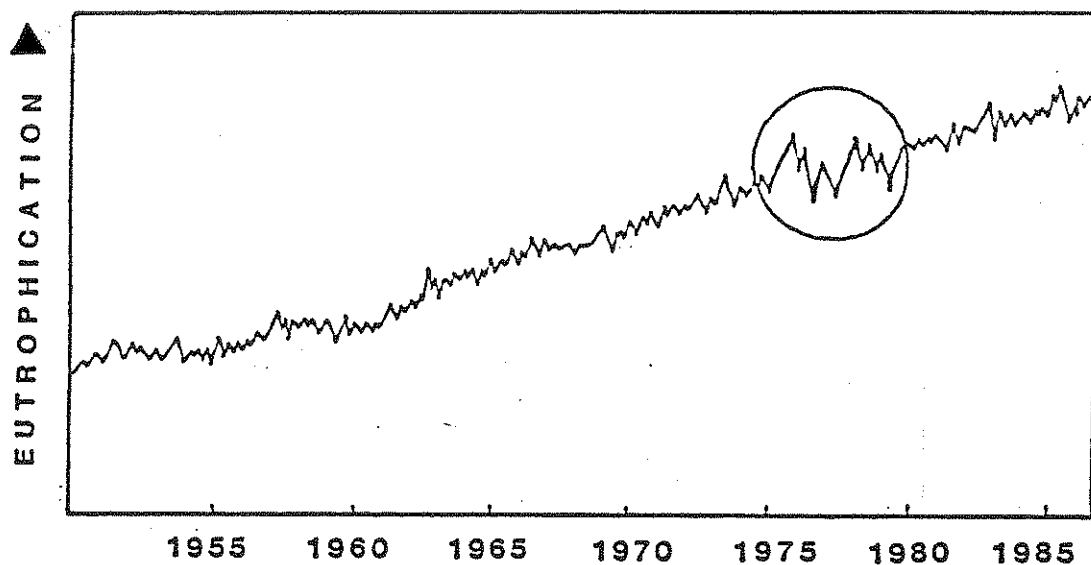


Figure 1. Long-term vs. short-term trends in a hypothetical lake approaching eutrophication.

ACKNOWLEDGEMENTS

Sunset Lake has participated in the Lakes Lay Monitoring Program since 1984. The program continued strongly in 1985 through the efforts of several dedicated monitors. Weely monitoring was done from a site at the center of the lake by Ralph and Eleanor Green, Woodbury Rodrick, and Martha Johnson.

The Freshwater Biology Group congratulates the monitors on the quality of their work and the time and effort put forth. We encourage them and other interested members of the Sunset Lake Association to monitor during the 1986 season. We would also like to thank Mr. Ralph Green for his dedication to the maintenance and organization of the LLMP for the lake.

Members of the Freshwater Biology Group (FBG) included Kim Babbitt, Henry Burke, Tracy Kenealy, Sandra Lord, Elizabeth Trieff, Celia Acacia, and Deb Thunburg. Kim was the LLMP Coordinator, and was responsible for arranging the field trips and supervising the research team. Liz and Sandy were responsible for phosphorus, Henry for equipment production and upkeep, Celia for phytoplankton, and Deb for zooplankton. Tracy was responsible for data entry and analysis, and for writing the reports in the fall. All members of the FBG participated in the field work and lab analyses.

We would also like to recognize the UNH Office of Computer Services for their provision of computer time and data storage space. The final text is available on an IBM-compatible diskette.

NON TECHNICAL SUMMARY OF LAY MONITOR DATA

1) Both water transparencies and chlorophyll a concentrations indicate that Sunset Lake is oligotrophic. Seasonal readings for secchi disk and chlorophyll suggest that the lake is nutrient-poor and contains relatively few planktonic algae.

2) This year, alkalinity was measured frequently on the lake. Alkalinity measures the ability of a lake to buffer acids. Alkalinities on Sunset Lake were high, indicating that the lake has sufficient buffering capacity at this time to resist the effects of acid rain.

3) The seasonal mean for dissolved water color was low, indicating that the water is not highly stained from dissolved humic substances (dark-colored organic matter). Both water color and the density of algae will affect the water transparency (secchi disk depth).

4) Levels of total phosphorus were low in Sunset Lake. Phosphorus is the nutrient that limits lake productivity the most. Low levels such as those found in Sunset indicate that the lake is relatively unproductive and that nutrient loading is limited.

5) The water in 1985 was more transparent than 1984, but contained more green coloring from suspended algae. Short-term fluctuations such as these are common, possibly due to changes in the weather from year to year.

COMMENTS AND RECOMMENDATIONS

1) We recommend that the Sunset Lake Association continue its long-term monitoring program in 1986. The Association has established a two-year data base that can be strengthened through further monitoring. A data base resulting from several years of monitoring will be a valuable resource in the future when apparent trends in the chemistry and biology of the lake become evident.

2) The Freshwater Biology Group (FBG) has never made a comprehensive chemical and biological survey of Sunset Lake. We recommend scheduling a trip in 1986. Data from the FBG will support data from the lay monitors as well as provide information on parameters such as pH, phytoplankton and zooplankton that the lay monitors do not test for.

3) Phosphorus sampling should be continued in 1986. While levels in 1985 were low, phosphorus concentrations can fluctuate from year to year in response to variations in the weather and activity on the lake. It is important to detect such changes as they occur, as high levels of phosphorus will lead to increased productivity (algal growth), which in turn may accelerate the eutrophication process.

4) Although Sunset Lake has high alkalinity at this time, monitoring for this parameter should be continued in the future. The alkalinity can decrease over a several-year period, and once it becomes too low, the pH of the lake will decrease, affecting animals and plants in the lake.

5) As a general addition to our Lakes Lay Monitoring Program, we are suggesting that each lake in the Program begin monitoring the condition of the fish taken from the lake. The "Fish Monitoring" will require that at least one lay monitor record the species, length and weight and collect a sample of fish scales for each fish examined. In most lakes this will involve periodic creel census of sport fishermen on the lake. Equipment required will cost approximately \$100. Special instruction will be given to the lay monitors who chose to measure this parameter.

Length-to-weight ratios give a measure of the nutritional condition of the fish. Analysis of the fish scales (to be done at UNH) will tell how old each fish is. Together, these data will be extremely useful indicators of the health of the fish populations in the lake, and, of course, the "health" of the lake.

METHODS OF LAY MONITORS

This year data were collected on five parameters: thermal stratification, water clarity (secchi disk depth), chlorophyll a concentration, alkalinity, total phosphorus and dissolved water color. Whenever possible, testing was done weekly between the hours of 9 am and 3 pm, the period of maximum sunlight penetration into the water. All samples and data were mailed to the FBG at UNH for analysis.

Thermal (temperature) profiles were obtained by collecting lakewater samples at several successive depths using a modified Meyer bottle (Lind, 1979). A weighted, empty bottle with a stopper was lowered to a specific depth. At that depth, the stopper was pulled, allowing the bottle to be filled with water. The bottle was quickly pulled back up to the surface where the temperature of the sample was taken with a Taylor pocket thermometer, and recorded in degrees Celsius. This procedure was repeated at one meter intervals through the epilimnion and hypolimnion, and at one-half meter intervals throughout the metalimnion.

Water clarity was measured by lowering a secchi disk (approximately 20 cm. or 8 inches) through the water off the shady side of the boat, and noting the average depth at which it disappeared upon lowering and reappeared when being

raised (the cord attached to the secchi disk was marked in one-half meters). This process was done while holding a view-scope just below the surface to eliminate effects of surface reflection and wave action. This was repeated two or three times, and an average to the nearest one-tenth of a meter was recorded.

Chlorophyll a concentration was used as an index of algal biomass that is useful in determining the trophic state of the lake. A weighted plastic tube (10 meters in length) was lowered through the epilimnion, or "upper lake" to the top of the metalimnion, or "middle lake" (the depths of the epilimnion and metalimnion are determined from the temperature profile). The end of the tube above water is folded to shut off the water flow into or out of the tube. The weighted end of the tube is pulled up out of the water with an attached cord, trapping an integrated sample of water representing the "upper lake" in the tube. This sample is poured into a plastic 2.5 liter bottle and stored for chlorophyll filtration and alkalinity determination.

Water samples for chlorophyll a filtration were filtered through a 0.45 micron membrane filter. Damp filters, containing chlorophyll-bearing algae, were air-dried for at least 15 minutes, out of the sun, to prevent decomposition or bleaching of the chlorophyll on the filter. These filters were sent to UNH where members of the FBG analyzed them for chlorophyll a (see Methods of the Freshwater Biology Group).

Dissolved water color was determined by saving the filtrate from the the chlorophyll filtration and storing it frozen in a 50 ml plastic bottle. The bottles were sent to UNH and the color was analyzed by reading the absorbance of the samples at two different wavelengths (440 and 493).

Samples for total phosphorus analysis were collected in two ways. For determination of epilimnetic phosphorus, water was taken from the integrated sample collected with the tube-sampler. On parts of the lake where it was suspected that phosphorus might be high, (eg. sites along the shoreline, inlets or outlets), surface samples were taken by dipping a bottle into the water and letting it fill. All samples were collected in acid-washed 250 ml bottles, fixed with 1.0 ml of concentrated sulfuric acid, and stored frozen until analysis by the FBG team. (See Methods by the Freshwater Biology Group.)

METHODS OF THE FRESHWATER BIOLOGY GROUP

Laboratory Methods

The Freshwater Biology Group (FBG) was responsible for chlorophyll a and phosphorus analysis, as well as filing and analyzing 1985 data, performing statistical tests, and determining possible trends based on past data.

The chlorophyll a content was analyzed by extracting the chlorophyll with a 95% acetone solution saturated with magnesium carbonate. The samples were then centrifuged and their light absorbance read at two standard wavelengths (663 and 750 nanometers).

Phosphorus samples were received by the FBG in a cold or frozen state, and were stored refrigerated until they were analyzed. To determine the total phosphorus content, ammonium persulfate and 11 N sulfuric acid was added to digest the total phosphorus, and the samples were autoclaved for one hour. Then, a single-reagent method was employed using potassium antimony tartrate, ammonium molybdate, and a fresh solution of ascorbic acid (E.P.A. 1979). Absorbance of the blue phosphorus complex was measured with a spectrophotometer at 650 nm. Each sample was analyzed twice and an average of the two values taken as the phosphorus content in parts per billion (micrograms per liter).

How the data are analyzed

Incoming data are received through the mail during the sampling season and are first filed in an "incoming data" book. This provides temporary storage until the corresponding chlorophyll and/or phosphorus sample for each data sheet is analyzed. All data, including date, lake, site, secchi disk depth, chlorophyll a and phosphorus content, alkalinity, and color measurements, are filed and stored on a computerized data-management system of the University of New Hampshire. Data can be easily retrieved by lake, sampling station or date, and used for individual reports and for each year.

Statistical treatment of the data for each lake includes a comparison of seasonal tendencies found throughout the year, monthly means for the different parameters tested, and confidence levels for each site. The same comparisons mentioned above are made on a yearly basis if the lake has been in the program for two years or more. If sufficient data are available from several years, regression analyses and other statistical tests are performed. Such analyses may identify trends and help explain variations in the data (eg. secchi disk depth, chlorophyll a, color). In addition, data is compared with other lakes in the program and to published water quality classifications. Trophic boundaries of Forsberg and Ryding (1980) are used to classify each lake.

RESULTS OF LAY MONITOR DATA

Weekly monitoring was done from site "5 Center" (Figure 2) from July 1 through November 16, 1985. See Appendixes A and B for lay monitor data for 1984-1985.

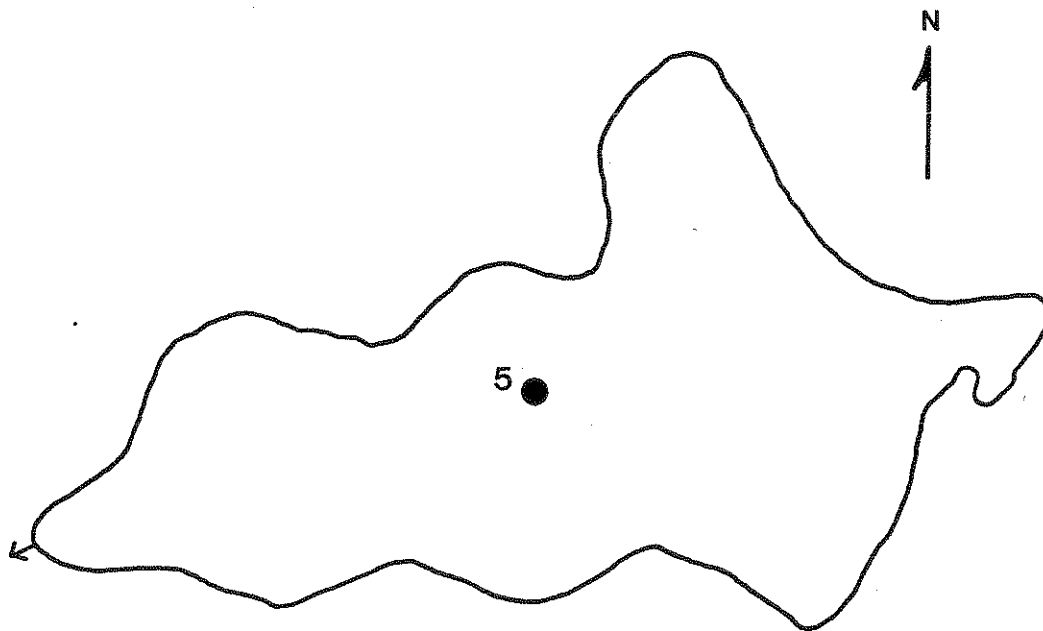


Figure 2. Sunset Lake, Hampstead, New Hampshire.
Map and location of 1985 sampling site.

Water Transparency and Chlorophyll a

Water transparency (secchi disk depth), was in the range from 4.5 to 7.0 meters (m), with an average of 5.2 m. Water transparency was relatively low in July (average 4.9 m), lowest in August (average 4.6 m), and highest September through November (average 6.3 m). The average chlorophyll a concentration was 2.3 milligrams per cubic meter (mg/cubic m). It was highest in July (average 3.2 mg/cubic m) and lowest in September (1.1 mg/cubic m). No chlorophyll data were available during October and November.

The water transparencies and chlorophyll a concentrations indicate that Sunset Lake is oligotrophic, based on trophic state boundaries of Forsberg and Ryding (1980). In 1985, the water transparencies and chlorophyll a concentrations were higher than in 1984. This may be due to differences in the weather for the two years, as similar results were found for several other lakes in the LLMP.

Dissolved Water Color

The dissolved water color, which is the brown coloring of lakewater due primarily to dissolved humic acids, was very low on Sunset Lake. Measured as the absorbance of light per 5 centimeters at 440 nanometers, it averaged 0.01. This is slightly lower than the average for lakes in the LLMP in 1985, indicating that Sunset Lake has little staining compared to many other New Hampshire lakes.

Dissolved water color is another factor in addition to the chlorophyll a concentration which influences the secchi disk depth. The lower the water coloring, the more light can penetrate the water column, and the higher the water transparency.

Alkalinity

Lay monitor alkalinity testing in 1985 was started in early- August and continued weekly through mid-November. Values at the final endpoint (pink) were high for New Hampshire, ranging from 12.6 - 14.0 milligrams calcium carbonate per liter (mg/l), with an average of 13.4 mg/l. The average alkalinity for lakes in the LLMP is approximately 9 mg/l. The results for Sunset Lake indicate that the lake has sufficient buffering capacity (alkalinity) at this time to resist effects of acidification.

Total Phosphorus

Sunset Lake was sampled for total phosphorus weekly during August and September. The average phosphorus concentration was 5.0 micrograms per liter (ppb), ranging from 2.2 - 7.1 ppb. Values in this range are low, and based on total phosphorus, the lake would be classified as oligotrophic. Low phosphorus concentrations indicate low levels of nutrient loading into a lake, thus low levels of algal productivity (assessed by the chlorophyll a concentration).

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APPENDIX A

LLMP -- Lay Monitor Data: Sunset Mar-24-86 16:03.41
 Date Lake Site SDD Chl

May-21-84	Sunset	5 Center	3.00	---
Jun-08-84	Sunset	5 Center	3.60	---
Jun-22-84	Sunset	5 Center	3.00	---
Jul-02-84	Sunset	5 Center	3.90	---
Jul-10-84	Sunset	5 Center	4.50	1.21
Jul-20-84	Sunset	5 Center	4.50	1.52
Aug-03-84	Sunset	5 Center	4.30	1.78
Aug-10-84	Sunset	5 Center	3.50	---
Aug-17-84	Sunset	5 Center	3.50	2.86
Aug-26-84	Sunset	5 Center	4.50	1.21
Sep-08-84	Sunset	5 Center	4.50	1.07
Sep-18-84	Sunset	5 Center	4.50	1.93
Sep-30-84	Sunset	5 Center	5.50	.09
Jul-01-85	Sunset	5 Center	5.00	7.43
Jul-07-85	Sunset	5 Center	5.00	4.43
Jul-13-85	Sunset	5 Center	5.00	1.64
Jul-18-85	Sunset	5 Center	5.00	1.57
Jul-27-85	Sunset	5 Center	4.50	1.21
Aug-02-85	Sunset	5 Center	4.80	1.93
Aug-08-85	Sunset	5 Center	4.50	2.14
Aug-17-85	Sunset	5 Center	4.60	2.50
Aug-23-85	Sunset	5 Center	4.60	.93
Sep-01-85	Sunset	5 Center	4.80	1.07
Sep-08-85	Sunset	5 Center	5.75	1.07
Sep-13-85	Sunset	5 Center	5.20	1.14
Sep-29-85	Sunset	5 Center	6.00	---
Oct-08-85	Sunset	5 Center	6.50	---
Nov-16-85	Sunset	5 Center	7.00	---

>>> END OF LIST <<<

APPENDIX B

LLMP -- Lay Monitor Data: Sunsen Mar-24-86 16:06.57

Date	Lake	Site	Alk (ppm)	Tot-P
Jul-18-85	Sunset	5 Center	---	2.2
Aug-02-85	Sunset	5 Center	---	5.3
Aug-08-85	Sunset	5 Center	13.5	5.8
Aug-17-85	Sunset	5 Center	12.6	7.1
Aug-23-85	Sunset	5 Center	12.8	6.6
Sep-01-85	Sunset	5 Center	13.4	4.1
Sep-08-85	Sunset	5 Center	---	4.1
Sep-13-85	Sunset	5 Center	13.5	4.6
Oct-08-85	Sunset	5 Center	14.1	---
Nov-16-85	Sunset	5 Center	13.7	---

>>> END OF LIST <<<

NOTE

There are three levels of reports available to participating lake associations in the LLMP. They are differentiated as follows:

LEVEL I - This is a basic report that includes sections on the methods employed, comments and recommendations, and a brief summary of results. It also contains an appendix listing data from the present and past years.

LEVEL II - This is a mid-level report that includes methods employed, a non-technical summary of lay monitor and FBG data, comments and recommendations and an in-depth results and discussion section. It contains an appendix listing data from the present and past years.

LEVEL III - This is a full report which includes the following sections: methods employed, a non-technical summary, comments and recommendations, a technical summary, and a complete results and discussion section supplemented by computerized graphics. It also contains 3-4 appendixes: a listing of present-year and past data, limnological concepts and technical terms, and a glossary.

